WATER QUALITY MONITORING STRATEGY FOR THE SOUTH SHORE ESTUARY RESERVE (SSER) LONG ISLAND, NY

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Biographical Sketch of Author

Elizabeth Moran is President of EcoLogic LLC a small environmental consulting firm located in Cazenovia New York. She earned her Master of Science and Doctor of Philosophy degrees at Cornell University in the field of Aquatic Sciences. Dr. Moran has more than 20 years of experience in limnology and water quality. She has served as technical lead on a number of watershed projects and has worked with multi-disciplinary teams of planners, engineers, and scientists to define the interrelationships between land use, point and nonpoint sources of pollution, water quality, and ecological integrity of surface waters.

Abstract

The South Shore Estuary Reserve (SSER) is a series of interconnected embayments between Long Island and Fire Island, the barrier island along the Atlantic coast. A Management Conference for the resource was formed to include representatives of the multiple stakeholders in this populous region of New York. The Management Conference was staffed by the New York Department of State. Nearing the end of their work, the Conference recognized the need for a water quality monitoring strategy to help assess the effectiveness of their recommended actions and the need for additional controls. EcoLogic developed a strategy using an interactive process that began with a workshop of stakeholders to elicit specific objectives for the resource. Next we interviewed representatives of the many agencies involved in aspects of water quality monitoring or resource management. We included questions regarding the water quality and ecological status of the SSER and perceived challenges to effective resource management. We constructed a database of parameters, frequency, spatial locations, depths, analytical methods, and data handling techniques to help identify gaps and redundancies in monitoring programs. From the workshop and interviews, we developed a list of management issues; some elements were specific to the SSER while others were characteristic of all estuaries. We focused this list into specific hypotheses that could be tested by water quality monitoring. The next step was a gap analysis. We examined the effectiveness of existing programs to test these specific hypotheses and identified areas where additional monitoring would be required. Finally, we developed the comprehensive water resources monitoring strategy needed to collect data to test the management hypotheses. The presentation will discuss this process and the challenges associated with examining agencies' established programs.

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The Nature of the Resource

The South Shore Estuary Reserve encompasses a series of shallow well-mixed estuarine embayments bounded by the southern shore of Long Island and a 75-mile barrier landform separating the embayments from the Atlantic Ocean. Ocean water flows into the SSER through five confined inlets that have breached the barrier islands. Freshwater inflows from the 320 km^2 watershed enter the SSER through three main rivers and numerous small streams. In addition, groundwater inflows are estimated to contribute 11% to the annual hydrologic budget.

Long Island is an urbanizing watershed, particularly in the western portion of the Reserve, and the SSER has been affected by changes in hydrology and materials loading. The potential presence of pathogens as indicated by elevated levels of coliform bacteria from stormwater and point source discharges has caused closure of significant areas of shellfish beds. Extensive areas of natural wetlands have been altered or filled, and exotic plant species have encroached into the terrestrial, wetland, and aquatic ecosystems.

Nutrient concentrations and primary productivity are high. However, the shallow well-mixed nature of SSER embayments limits hypoxic conditions to restricted areas near tributaries' mouths. Low DO has also been reported in downstream reaches of some of the larger tributaries. Growth of macroalgae reaches nuisance levels in the western embayments. Periodic blooms of brown tide appear to be among the factors contributing to the dramatic decline in the hard clam fishery. Excessive algal growth and turbidity affect light penetration and reduce habitat for submerged aquatic vegetation.

Guiding Principles of the Monitoring Strategy

The monitoring strategy was developed to support the Comprehensive Management Plan for the South Shore Estuary Reserve (SSER). The Comprehensive Management Plan presents goals and objectives for the estuarine system; the Monitoring Strategy describes which physical, chemical, and biological parameters should be measured to assess progress towards achieving water quality goals.

The Monitoring Strategy takes an ecosystem approach to water quality monitoring. Water quality in the SSER is the result of complex interactions among the ocean, the estuary, and the land. Land and water-based activities affect water quality and habitat. Physical factors such as hydrologic inflows and circulation are important forcing functions of the estuarine system, and are closely coupled to chemical water quality. The biological community both responds to and alters the physical and chemical environment. Consequently, the monitoring strategy includes elements to track these functional relationships.

Six principles guided development of the SSER monitoring strategy.

(*1) Turn Data into Information, then into Strategic Information.*

This evolution is a central attribute of any effective monitoring program. Data are the results of individual measurements of the physical, chemical, and biological attributes of the system. Data become information when they are compiled and used to test a conceptual framework of the nature of the aquatic system. Information becomes strategic information when it provides a basis for informed decision making.

(2) Maximize utility of existing programs

Many stakeholders have research or monitoring programs within the SSER. We considered maintaining the integrity of existing programs among the guiding principles because of the importance of baseline information. Whenever possible, the locations and parameters used in the existing programs were retained. This allowed the data to be used for trend analysis or to test the effectiveness of specific control actions using a before and after approach. Historical data were also factored into program design. Measured spatial and temporal variability of water quality parameters provided a quantitative basis for defining the optimal sampling frequency to detect changes of a defined magnitude.

(3) *Incorporate a quality assurance/quality control (QA/QC) program to document data quality and estimate sampling and analytical sources of variability.*

A QA/QC program is a systematic program of planning for and documenting the integrity of the procedures used to collect and analyze samples. It can be expanded to assess the processes used for data management as well. With multiple agencies involved in monitoring, a QA/QC program enables managers to assess comparability of data sets and determine the extent to which system-wide comparisons can be drawn. When volunteer monitoring programs include a formal QA/QC program, the utility of the information generated is greatly enhanced. A program of replicate samples, split samples, and audit samples was recommended to identify sources of variability in data and provide feedback to the participating agencies regarding the need to revise their procedures.

(4) Remain flexible to respond to new information

The Monitoring Strategy reflects current management objectives, water quality conditions, and availability of quantitative tools. All three elements are subject to change; necessitating regular review and update based on new information.

(5) Include "capstone indicators," organisms that, by their presence or absence, provide information regarding the ecological status of the community.

Presence and abundance of single populations can provide important information regarding overall water quality conditions. Key indicator species may be of high value as an economic resource, such as the hard clam (*Mercenaria mercenaria*) or high importance for habitat value such as the SAV eelgrass (*Zostera marina*). Other criteria for indicator species include their relative susceptibility or tolerance to adverse water quality conditions, their ease in measurement, and whether density of the organism is correlated with the extent of contamination.

The presence of nuisance or toxic species of phytoplankton (e.g. *Aureococcus anophagefferens,* brown tide) is another capstone indicator providing information regarding ecological status of SSER embayments. Health of individuals is another measure of ecosystem integrity. Disease, parasites, and accumulation of heavy metals and organic compounds are related to water quality conditions.

(6) Strive to be cost effective.

Monitoring is expensive. A coordinated approach will help eliminate any redundancies and increase the value of the overall investment in monitoring. The goal is synergism; in a well designed program, the value of each individual monitoring component is enhanced by being part of a larger whole.

Description of the Process

The monitoring strategy was developed through an interactive process that began with a stakeholder workshop to elicit specific goals and objectives for the estuarine resource. As the first step, EcoLogic staff led a workshop to elicit specific objectives for the SSER. Participants were asked to imagine the SSER 20 years after implementation of the Management Plan and describe (in specific terms) what the estuary was like. Responses focused on four inter-related areas:

(1) Use attainment.
(2) Elimination or controls on pollutant inputs that contribute to water quality conditions that impair SSER waters for their desirable use.

(3) Restoration or enhancement of the natural ecosystem.
(4) Implementation of effective tools for managing the SSER.

We concluded from the workshop that an effective monitoring strategy would provide data and information regarding the magnitude and relative significance of contaminant inputs, status of water quality with respect to standards, criteria and guidance values associated with human use attainment, and metrics of ecosystem health.

Following the workshop, EcoLogic staff completed a series of detailed interviews with representatives of agencies and groups involved in aspects of water quality monitoring or resource management. Topics covered during the interviews included the objectives and details of current research or monitoring programs. We also asked open-ended questions regarding the water quality and ecological status of the SSER and perceived challenges to effective resource management. We compiled the information into a database with detailed listings of parameters, frequency, spatial locations, depths, analytical methods, and data handling techniques. This database was used to help identify gaps and redundancies in monitoring programs.

From the workshop and interviews, we developed a list of issues related to the broad objectives of ecological integrity (chemical, physical and biological attributes) of the SSER. The list included some elements specific to this system and other elements characteristic of estuaries in general. Next, the list of issues was formulated as a series of hypotheses that would be tested by monitoring and analysis.

Once the overall objectives were formulated as a series of hypotheses, the existing programs were examined for their effectiveness in testing these specific hypotheses. Our team identified areas where additional monitoring would be required. Finally, a comprehensive monitoring program was designed to capture all the recommended actions on the appropriate spatial and temporal scales.

Draft reports were reviewed by stakeholder groups and many comments were received. The monitoring strategy was revised multiple times to reflect the input of the involved and affected groups. Each round of revisions resulted in a more complex monitoring strategy due to the overarching interests of the research community, regulatory agencies, and groups interested in citizen monitoring initiatives.

Elements of the Monitoring Plan

The outcome of this highly interactive process was a monitoring plan for the SSER designed to assess progress towards achieving water quality and ecological goals. The monitoring program includes physical, chemical, biological, and human-induced attributes of the estuarine system and its watershed. Strategies were identified to improve coordination in sample locations, parameters, and data handling.

A central recommendation was to identify a leader and an annual process for continued coordination among the multiple parties. One agency and individual within the agency should serve as overall program manager. This leader would be responsible for coordinating activities of participating agencies and serving as a point of contact for data and information. Examples of responsibilities of the program manager include:

- Reviewing detailed monitoring plans of participating agencies.
- Developing and distributing protocols for unified data handling, including data screening.
- Overseeing data analysis (plotting and statistical analysis for trends).
- Maintaining a central database of results.
- Convening meetings to discuss results and decide whether modifications are needed.
- Advocating for funding of Tier 1 monitoring.
- Advocating with institutions and funding agencies for implementation of Tier 2 programs.

- Preparing an annual summary “State of the SSER” report.
- Meeting with the public to discuss progress.

The technical parts of the program were conceptualized as a tiered monitoring program, with a baseline program (Tier 1) designed to assess trends in water quality and the extent to which desired uses of the SSER (from both the human and ecological perspective) are met.

Tier 2 activities were envisioned as short-term investigations, more intensive in temporal and/or spatial scale, designed to test specific hypotheses regarding water quality or ecological issues in the SSER. A number of significant questions remain regarding the nature of the system and Tier 2 projects can be designed to fill these data gaps. These recommended activities reflect the current status of the resource and gaps in understanding of how it functions. By their nature, Tier 2 activities are dynamic.

Conclusions

An interactive process was used to identify and interview the many stakeholders involved in research and monitoring activities within Long Island’s South Shore Estuary Reserve. Similar to the nature of the estuarine system itself, the agencies and groups involved in monitoring form a loosely-coupled network responding to external and internal forcing functions. The EcoLogic team endeavored to state the disparate research and monitoring objectives in terms of testable hypotheses related to goals and objectives for managing the resource. We also recommended an institutional structure for coordinating monitoring program design, data handling and interpretation, and responding to public inquiries. Significant progress has been made. One public (county) agency has taken a leadership role and is working to standardize analytical parameters and methods. Much work lies ahead to continue the process.